AAA-RL-TR-85-3V

GUIDELINES FOR TEAM CRITERION TASK SET (U)

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This report presents material relating to the proper assembly and operation of the Criterion Task Set (CTS). The CTS is a battery of tests designed to place selective demands on the elementary mental resources and information processing functions of the human operator (see Shingledecker, 1984, for a discussion of the theoretical background of the CTS).

The present report provides detailed information with respect to: (a) system hardware, (b) system assembly, (c) data collection, and (d) data analysis. Instructions to subjects are provided for each task. Furthermore, sample printouts of raw and summarized data are provided for three selected tasks.

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PREFACE

This report documents equipment requirements and operating procedures for a human performance test battery known as the Criterion Task Set (CTS). The effort which led to the construction of the CTS was performed in support of AFSC Project 7184, Man-Machine Integration Technology, by the Harry G. Armstrong Aerospace Medical Research Laboratory (AAMRL), Human Engineering Division, Wright-Patterson Air Force Base, Ohio 45433-6573.

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Section 1
INTRODUCTION

The Criterion Task Set (CTS) is a battery of performance tasks developed for use as a standardized test instrument that can be applied to a number of general problem areas relating to the prediction and assessment of human performance. This is one of two technical reports which serve as documentation for the CTS. The first (Shingledecker, 1984) presents a discussion of the theoretical issues and practical considerations which guided the development of the CTS, along with descriptions of the individual tasks composing the battery. This report presents supplementary material relating to the proper assembly and operation of the CTS system, and to its use for testing human subjects.

Briefly, the CTS consists of a number of psychomotor and cognitive tasks that are designed to impose demands on the functional information processing resources of the human operator as they are utilized in Air Force systems. Selection of component tasks was based on a working model of the human information processing system which was synthesized from the literature on cognitive function. To simplify the task selection process, the model was operationally defined in terms of task characteristics that could be presumed to place primary demands on each of its represented elements. Based on the task characteristics relating to the model and on a number of practical selection criteria (such as face validity and demand manipulability), a number of candidate tasks were chosen from the cognitive performance literature. The candidate tasks were subjected to empirical study in order to establish significantly different task demand conditions, and to determine appropriate training schedules and stimulus pacing rates. The current version of the battery (CTS V1.2) represents a preliminary group of loading tasks and operating procedures that will almost certainly undergo modification. Nevertheless, the battery may be expected to provide valuable information on the locus of information processing decrement produced by a variety of environmental and procedural variables.

The CTS is implemented on an inexpensive microcomputer system, and requires a minimum of custom built hardware. To facilitate its use, the component

tasks have been programmed in a standard, menu-driven format that is both uncomplicated and flexible. The following sections of this report describe the CTS hardware (with directions for assembling it), the sequences of menus and program queries that are encountered during task use, and suggestions for efficient operation of the system. Additionally, task instructions and other aids for utilization of the battery are included as appendices to the main text. The objective is to provide basic information on the operation of the CTS so that the novice user can collect data with a minimum of error and confusion.

Section 2
THE CRITERION TASK SET HARDWARE SYSTEM

The CTS hardware system requires five major pieces of hardware, three subject response devices, a video switch for the subject's monitor, and associated cables. In this section, the system components are thoroughly described and instructions for connecting them are provided. While all of the major hardware components are commercially available, the response devices, video switch box, and many of the connector cables must be constructed by the individual user. Appendix A contains descriptions of the response devices and the video switch which are sufficiently detailed to permit fabrication of operational hardware. Specifications for connector cables are given in the text.

EQUIPMENT LIST

The five major pieces of hardware contained in the system include (1) a Commodore 64 computer, (2) a Commodore 1541 disk drive, (3) a Commodore 1702 color monitor, (4) a printer, and (5) a monchrome monitor.

1. The Commodore 64 computer is supplied with a user manual, a power supply, and a coaxial cable and switch box for connecting the computer to an ordinary television set. (The cable and the switch box ARE NOT USED in the CTS hardware system.)

2. The disk drive is supplied with a user manual, a utility diskette, an AC power cord, and a six-conductor cable for connecting the drive to the computer's serial bus. (The utility diskette IS NOT USED in the CTS hardware system.)

3. The Commodore color monitor is supplied with a user's manual. Additionally, a special video switch box, a 5-foot coaxial cable with BNC connectors on each end for connecting the video switch box to the monochrome monitor, and a 5-foot coaxial cable with a BNC connector on one end and an RCA phono plug on the other end are required. The second coaxial cable is used to connect the

video switch box to the "luma" input on the color monitor. The video switch box and connector cables are not included with the Commodore monitor, and must be custom built.

4. The dot matrix printer is supplied with a manual, and requires a specially constructed six-conductor cable for connecting the printer to the serial bus jack on the disk drive.

5. The monochrome monitor is accompanied by a user's manual. A special video cable must be fabricated to connect the video output from the computer to the monochrone monitor and to connect the color and audio signals from the computer to the "chroma" and "audio" input jacks, respectively, on the color monitor.

DIRECTIONS FOR SYSTEM ASSEMBLY

Directions for assembling system hardware should be carefully followed. Special attention should be given to the CAUTION statements, which describe inappropriate practices that may damage the computer or peripheral devices.

Step 1: Five AC electrical outlets are needed to supply power to all hardware. Plug the grey AC power cord packed with the disk drive into the AC jack on the back of the disk drive. Make certain the ON/OFF switch (on the back) is set to the OFF position. Plug the other end of the AC power cord into an AC electrical outlet. Remove the cardboard sheet from the opening in the front of the drive. Connect the six conductor serial bus cable (packed with the disk drive) to EITHER serial bus port at the rear of the computer.

CAUTION

Do not place papers or any other objects on top of the disk drive. Data loss and/or serious damage to the disk drive due to overheating may occur.

Under no circumstances should the six conductor serial bus cable be connected to or removed from the computer or the disk drive or the printer when either the computer or the disk drive or the printer is ON.

Step 2: Plug the color monitor into an AC outlet. The ON/OFF switch is a pushbutton on the front panel. Volume and other controls are behind a door on the front panel. All controls including volume must be adjusted for proper operation. Make certain that the "signal select" switch near the jacks on the back is set to the "rear" position.

CAUTION

Do not place papers or any other objects on top of the color monitor. Damage to the speaker and damage from magnetic fields can occur.

Step 3: Make certain that the ON/OFF switch on the left side of the printer is in the OFF position. Plug the AC power cord into an AC electrical outlet. The printer is designed to use standard 9 1/2-inch, tractor-feed, fanfold paper. (Lightweight paper generally gives better performance than the heavier bond papers.) Refer to the user's manual for instruction on loading paper. Connect the six conductor cable (packed with the printer) to EITHER serial bus jack on the disk drive. All other adjustments have already been made. Make certain that the device switch at the rear of the printer (if present) is set to "4."

CAUTION

Under no circumstances should the six conductor serial bus cable be connected to or removed from the computer or the disk drive or the printer when either the computer or the disk drive or the printer is ON.

Step 4: Make certain that the monochrome monitor is switched OFF. Plug the monitor into an AC power outlet.

Step 5: Make certain that the computer is switched OFF. The ON/OFF switch is located on the right side, near the power input jack. Connect the 4 pin DIN plug from the power supply to the power input jack. Plug the AC power cord into an AC electrical outlet.

VIDEO AND AUDIO CONNECTIONS

Step 1: A special video/audio cable with an 8 pin DIN plug on one end, and two RCA phono plugs and a BNC connector on the other, is required for the monochrome monitor. Insert the DIN plug into the video/audio jack on the back of the computer. Connect the BNC connector on the special video/audio cable to the video input jack on the back of the monochrome monitor. Connect the red and black RCA phone plugs to the "chroma" and the "audio" input jacks, respectively, on the color monitor.

Step 2: The color monitor is connected to the monochrome monitor via the video switch box with two 5-foot cables. Connect the cable with BNC connectors on both ends to the video input jack on the monochrome monitor and to either BNC connector on the video switch box. Connect the cable with a BNC plug on one end and an RCA phono plug on the other to the video switch box and to the "luma" inut on the color monitor, respectively.

BRINGING UP THE SYSTEM

To power up the system, press the power switch on each piece of equipment in the following order:

1. Monitors
2. Disk Drive
3. Printer
4. Computer
5. Video Switch Box

If the system is working properly, the following screen prompt will appear on both monitors:

```
**** COMMODORE 64 BASIC V2 ****
64K RAM SYSTEM 38911 BASIC BYTES FREE
READY.
```

The background on the color monitor should be dark blue, and the letters and border should be light blue. The display sent to the color (subject's) monitor can be removed by switching the video switch to OFF. This enables the experimenter to select parameters on the CTS tasks without allowing the subjects to see which values are selected.

CONNECTING THE RESPONSE DEVICES

Because the various tasks in the CTS battery require different types of responses, three response devices are used with the CTS system. The four button keypad is used with all tasks except unstable tracking and the interval production task. The tapping switch is used with interval production and the rotary controller with unstable tracking. Instructions for connecting each type of response device are given below.

The Four Button Keypad

The four button keypad is connected to the computer's "user port." This is a 24 pin edge connector (12 pins per edge) located at the rear of the computer. The grey, 10-foot cable for the keypad has a 24 pin edge connector on one end and a 9 pin connector on the other. The 24 pin connector is plugged into the keypad and locked. IMPORTANT: The edge connector is not keypad, i.e., it can be plugged into the user port in either an upright or inverted orientation. The position is correct only when the cable is coming out of the left side of the computer as the user faces the keyboard.

CAUTION

Under no circumstances should the 24 pin edge connector be connected to or removed from the computer when the computer is ON. Serious damage to the computer may result.

The Tapping Switch

The tapping switch also connects to the user port, but cannot be connected simultaneously with the keypad. The cable for the tapper is a thin, black, coaxial cable with a 24 pin edge connector on one end and a BNC connector on

the other. The 24 pin edge connector plugs into the computer's user port, and the BNC connector attaches to the BNC jack on the tapper box.

CAUTION

Under no circumstances should the 24 pin edge connector be connected to or removed from the computer when the computer is ON. Serious damage to the computer may result.

The Tracking Controller

The tracking task controller plugs into the computer's "game port #1." The cable is a 6-foot black cord with 9 pin game connectors on both ends. The female end plugs into the computer and the male end plugs into the controller and locks with retaining chips.

CAUTION

Under no circumstances should the 9 pin game connector be connected to or removed from the computer when the computer is ON. Serious damage to the computer may result.

Section 3
COLLECTING AND ANALYZING DATA WITH THE CTS

The CTS tasks are structured in a simple, standard operating format to enhance their ease of use, reduce the probability of error, and minimize the amount of time required for the user to become familiar with individual tasks. Generally, program structure varies little from task to task. However, due to inherent task differences there are some deviations from the standard format. For example, the interval production task offers only a single loading level and, consequently, does not contain a demand condition menu. Also, since a variety of performance measures are obtained, there are slight variations between tasks in the output formats for printed and displayed data. In the outline of operating procedures below, computer queries/statements are indented and printed in capital letters. Appropriate user responses are indented and in capitals, and are also underlined to distinguish them.

LOADING THE DIRECTORY

All programs for the nine tasks composing the CTS V1.2 battery are contained on a single master program diskette. In addition, a directory program is included on the master disk so the user can easily load any task or switch from one task to another. To load a CTS task (assuming the system is correctly assembled, the computer and all peripherals turned on, and the master diskette inserted in the disk drive), enter:

LOAD"DIR",8 (return)

The computer will display in sequence:

SEARCHING FOR DIR
LOADING
READY

Next enter:

RUN (return)

After a short delay (during which the red light on the front of the disk drive is lit, indicating that the drive is reading information from the disk), the computer will display a list of the CTS tasks, each followed by a number. To load a task, enter the corresponding number and press the "return" key. When the program is loaded, the title page of the task chosen will appear on the screen.

THE STANDARD TASK FORMAT

Individual "pages" of the programs are discussed below in the order that they occur during normal task use.

Title Page

This is the first display that appears when a task is selected from the directory. It identifies the task and the version of the battery that is being used. Depressing any key (no carriage return required) will continue the program.

Input Menu

The input menu allows the user to initiate a data collection trial, analyze previously stored data from an earlier session, or check the operation of the response device used with the task. To select any option, enter the corresponding number and press the return key.

- Options 1 and 2: Practice and Experimental Trials. When either of these options is selected, a 3-minute data collection trial is executed. For those tasks consisting of a series of stimulus items requiring discrete responses (e.g., memory search or mathematical processing), practice trials allow the subject a maximum of 15 seconds to respond to each test item, regardless of the

demand level. In experimental trials, the stimulus deadline is considerably shorter and depends on the demand level in effect. Practice trials should be used when training subjects as the stimulus deadlines on experimental trials will usually be too fast for inexperienced operators. (See Shingledecker, 1984, for training requirements of individual CTS tasks.) For tasks that cannot be paced (e.g., probability monitoring or interval production), selection of a practice or experimental trial serves only to label the data for future reference.

- Option 3: Analyze Data. Allows the user to analyze data that were collected in a previous session. The procedure for this is described in the following section.

- Option 4: Keypad Check/Controller Test. This option allows the user to check the operation of the four button keypad or the rotary control knob. (A self-test is performed on the tapping switch after the first tap is entered in the interval production task.) The response device tests should be performed at least once at the beginning of a data collection session. For keypad response tasks, the keypad layout is displayed on the screen. To test the working status of individual keys, press each one in turn. The corresponding key in the display will change color if the key is operating properly. To exit the test, press any key on the computer. The controller test (unstable tracking) reads the position of the cursor on the screen in vertical screen units (pixels). If the controller is working, the displayed value will change continuously from -127 to +127 as the control knob is rotated. When the keypad and controller tests are exited, the program returns to the input menu.

Subject and Trial Codes

To collect data, the subject and the conditions under which he/she is to be tested must be identified. Subject and trial codes are stored on the data file to help identify the trial. The maximum acceptable length for subject

and trial codes is 17 characters. When this is exceeded, the code must be reentered. The trial code is used to specify testing conditions other than those generated by the CTS task, such as session number or drug type. All information on CTS testing conditions (e.g., demand condition, pacing deadline) is automatically stored.

After the subject and trial codes have been input, the user is cued by a screen prompt to insert the data disk for that subject into the drive.

Task Loading Menu

The task loading condition to be implemented on the next trial or the next set of three trials is selected from this menu. For all tasks but interval production, the following four options are available:

- Option A: Auto Sequence. The auto sequence option executes an automatic sequence of three trials in ascending order of difficulty. When operating in the automatic mode, new trials are immediately initiated by the computer after data from the previous trial has been saved to disk. Following storage of the data, the "Keypad Display/Start Data Collection" page (see below) appears. Any displaying or printing of raw or summarized data must, therefore, be done before the data are saved. At the end of the three trial sequence, the program displays a message indicating that the task is complete and returns to the output menu. The auto sequence option is intended to help streamline experimental procedures when a fixed condition order is acceptable, and is a feature of all tasks except probability monitoring.

- Options L, M, and H: Low, Medium, and High Demand. The level of task demand selected here is in effect on the subsequent trial only. The task parameter values defining each demand condition are noted on the menu.

Keypad Display/Start Data Collection

This page displays the keypad layout (for keypad response tasks) and indicates the type of response associated with each key. Additionally, the task demand condition for the next trial is shown on the screen. For all tasks but memory search, the subject initiates data collection at this point by pressing any one of the response keys. (An intermediate screen showing the "positive set" to be memorized follows in the memory search task.) Before beginning a trial, it is important that the subject note which key is used for each type of response. The necessary information is indicated on the keypad display. If a given key is to be used for many different responses in a single test session, subjects should be reminded of the response key configuration before each trial.

Data Collection

The nature of the stimuli and their pacing deadlines vary greatly for different CTS elements, but for all tasks several performance measures are computed for the standard 3-minute period. Suggested task instructions are provided in Appendix C. Additionally, Appendix D contains instructional graphics which can be used to describe the tasks or can serve as reminder cues to operators already familiar with the CTS.

Output Menu

The output menu offers six options which allow the data to be displayed on the monitor, permanently recorded (on paper and/or disk), and summarized in a few simple descriptive statistics. Menu items also allow the user to begin a new trial with the same task or select another task.

- Option 1: View Raw Data. Unsummarized (raw) data are displayed on the screen when this option is selected. With few variations, the following information is presented: (1) the time (from the onset of the trial) at which each stimulus was presented, (2) the correct response, (3) the response made by the subject (starred responses are incorrect; dashes indicate no response), (4) the

elapsed time from stimulus onset to response (reaction time), and (5) the actual stimulus item presented (in coded form for the spatial processing task). Outputs for the probability monitoring, unstable tracking, and interval production tasks deviate substantially from this standard format. Appendix B contains sample raw data displays for these tasks with brief explanatory comments.

- Option 2: Print Raw Data. Raw data are sent to the printer in approximately the same format as the sceen display. All data displayed on the screen are also printed, along with information about the testing conditions in effect. Filenames should be coded to indicate the subject, task, and test conditions associated with the data set.

- Option 3: Save Raw Data. Raw data are stored in a permanent diskette file. A unique file name (one that does not already exist on the data disk), not to exceed 15 characters, must be entered. If an existing file name is mistakenly entered, the computer will display:

  63 FILE EXISTS 0 0
  (PRESS ANY KEY FOR MENU)

  To attempt the save again, press any key and select the "save" option from the input menu again. If the new name is acceptable, the computer displays:

  SAVING FILE: [filename]

  When the save is completed, the program returns to the output menu or to the next level of the task if in the auto sequence mode.

- Option 4: Statistics. Summary statistics are computed, including (for most tasks) mean reaction time of correct responses, standard deviation of correct response times, and both counts and percentages of correct and incorrect responses. Incorrect responses are

categorized as either errors (responding with the wrong answer) or misses (not responding at all). The summary statistics option produces separate statistical calculations for positive and negative responses in the memory search task. Sample summary outputs for tasks having performance measures other than response time and error are also included in Appendix B. A suboption can be used to send summary statistics to the printer. After statistics are printed, the program returns to the output menu.

- Option 5: New Trial. A new trial should be initiated only when all desired data records (to printer or disk) have been created. When a new trial is started, data from the previous trial cannot be accessed except by reloading it from disk. The program returns to the input menu when the "new trial" option is selected.

- Option 6: End Task. The CTS task directory is automatically reloaded when this option is specified. Like the "new trial" option, this should only be selected after all necessary data records have been completed.

CAUTION

If the master program diskette is not inserted in the disk drive when the command is entered, the computer will unsuccessfully scan the current disk for the menu, then display an error message. To reload the directory, follow the procedure described earlier for loading the CTS directory.

ANALYZING DATA FROM DISK

The software used to analyze data stored on disk is embedded in each CTS task program. To analyze a set of data, the CTS task program that was used to collect it must, therefore, be loaded. To avoid repeatedly loading the same task program, it will be most efficient to analyze all data for a given task before analyzing data from another. Before performing data analyses, it may be necessary to determine which data files are stored on the data

disk. To do this, turn on all equipment in the system, insert the data disk into the drive, and enter:

LOAD"$",8 (return)

The "$" is the Commodore Basic symbol for the directory of file names on the disk. Next enter:

LIST (return)

The names of all files contained on the data disk will be displayed on the screen (whether they are data files or programs).

To analyze a data file, follow this sequence of steps:

- Step 1. Load the necessary CTS program.

- Step 2. Select the ANALYZE DATA option from the input menu.

- Step 3. Insert the data disk into the drive. (Warning: The computer does not provide a reminder cue to do this.)

- Step 4. Enter the data file name and press return. If the file name is not listed on the disk, the following error message will be displayed:

  62 FILE NOT FOUND 0 0
  (Press any key to return to menu.)

  The program will return to the input menu. If the file is located by the computer, the red light on the face of the drive will stay lit until the file has been read, and the output menu will appear.

- Step 5. Select the desired output option(s).

SPECIAL OPERATING FEATURES

Experimenter Cueing

When the experimenter cueing option is selected, a cue is displayed on the screen during data collection indicating the correct response. It is intended for use as an instructional aid, enabling the experimenter to demonstrate correct performance on tasks where the appropriate response may not always be obvious. Cueing is available only on the probability monitoring and spatial processing tasks, and appears immediately after the demand condition has been selected for a practice trial. The use of experimenter cueing is a necessity when demonstrating the medium and high demand conditions of the probability monitoring task, as the signals in these conditions can be quite difficult to perceive. The cue for probability monitoring biases consists of two numbers, the left indicating which dial is biased (1 through 4), and the right the direction of bias (1 = left, 2 = right). In the spatial processing task, the comparison histogram is accompanied by an "S" or a "D" (same or different) in the upper left portion of the screen.

The Video Switch

The video switch provides the capability to suppress the subject's display while task parameters are entered and data are analyzed. The switch box (described in Section 2) links the computer to the subject's monitor. Typically, the switch would be set to "on" when the keypad display/start data collection page is reached, and switched off again at the end of data collection.

Interrupting the Program with the Run/Stop and Restore Keys

By simultaneously pressing the run/stop and restore keys (located at the extreme left and right of the computer keyboard), the current program can be interrupted and the task restarted or terminated. The run/stop key should be held down and the restore key repeatedly pressed until the interrupt is accomplished. If successful, the screen is erased, and the word "ready" is displayed. The run/stop and restore interrupt is effective at any point in

the program, whether the computer is expecting a limited set of responses or not. The program is reverted to its original state, and all counters, variable values, and data storage buffers are zeroed. This method should, therefore, only be used to restart or abort a trial when all needed data have been stored on paper or disk. The run/stop restore interrupt is the simplest method to abort a trial or to exit a task, but should be cautiously applied.

Appendix A

EQUIPMENT DESCRIPTIONS FOR CUSTOM HARDWARE REQUIRED FOR THE CTS

FOUR BUTTON KEYPAD

The four button keypad contains four SPST pushbutton switches which are normally open. The switches should have low activation force requirements, provide at least a small amount of tactile and auditory feedback upon closure, require little depth for mounting, have minimal travel (i.e., a short "throw"), and be highly reliable. The principle of operation is that each switch is connected to ground (through a 1000 ohm current limiting resistor) and a bit line at the Commodore 64's user I/O port. Depressing the key causes the corresponding bit line to go "low" (i.e., the line is switched from a nominal +5 volts to ground). The four switches are numbered one through 4 and are connected to bit lines PB1, PB2, PB3, and PB4, respectively. The CTS task software is written to sense changes in bit values caused by keypresses.

TAPPER SWITCH

Essentially the same operating principles described for the four button keypad apply to the tapper switch except that the tapper contains a single SPST microswitch that is activated with a lever. The subject depresses the lever to close the switch. Again, the switch used should provide easy, low force activation, tactile and auditory feedback, short travel, and high reliability. The tapper microswitch is connected to ground (through a 1000 ohm current limiting resistor) and to bit line PB0 at the user I/O port.

TRACKING CONTROLLER

The tracking device contains a single 1 megaohm potentiometer that is connected between pin 7 and pin 5 (+5 volts and POT AY, respectively) at the Commodore 64's control port 1. The corresponding bit values change from 0 to 255 as the potentiometer is rotated from its stop at 0 degree (typically around 400 ohms) to about 75 degrees (which provides about 255 kilohms on a

potentiometer with 300 degrees of rotation). Further rotation produces no further changes in bit values. Again, the software is written to sense these changes in bit values. The critical requirement for the potentiometer is that it be noisefree and reliable. There should be no resistance in the external circuit.

VIDEO SWITCH

The video switch is simply an SPST toggle switch connected between the luminance output line (pin 1) of the Commodore 64's audio-video output DIN socket, and the LUMINANCE input jack on the Commodore 1702 color monitor.

Appendix B

SAMPLE PRINTOUTS OF RAW AND SUMMARIZED DATA FOR THE PROBABILITY MONITORING, UNSTABLE TRACKING, AND INTERVAL PRODUCTION TASKS

CTS PROBABILITY MONITORING TASK (STATISTICS)

SUBJECT: MSC
TRIAL: DAY1REP3
EXPERIMETER CUEING: NO

LEVEL: 3 DIAL(S)
SIGNAL PROBABILITY: 85%
DEADLINE: 32 SEC.

CORRECT = 2
FALSE RESPONSES = 1
MISSED BIASES = 0

CTS PROBABILITY MONITORING TASK (RAW DATA)

SUBJECT: MSC
TRIAL: DAY1REP3
EXPERIMENTER CUEING: NO
'*' DENOTES INCORRECT RESPONSE

LEVEL: 3 DIAL(S)
SIGNAL PROBABILITY: 85%
DEADLINE: 32 SEC.

TIME (SEC)	BUTTON PUSHED	DIAL/ SIDE	R.T. (SEC)	BIAS
11		1/1		BEGIN
33	1	1/1	21.7	
33				END
92		3/2		BEGIN
105	3	3/2	12.7	
105				END
125	1*	X/X		

CTS UNSTABLE TRACKING TASK (STATISTICS)

SUBJECT: WHA
TRIAL: DAY4DRUGC

LEVEL: LAMBDA 1
TRIAL TYPE: PRACTICE

MEAN ABSOLUTE ERROR: 10
TOTAL EDGE VIOLATIONS: 4

CTS UNSTABLE TRACKING TASK (RAW DATA)

SUBJECT: WHA
TRIAL: DAY4DRUGC

LEVEL: LAMBDA 1
TRIAL TYPE: PRACTICE

TIME (SEC)	ABS. ERROR	EDGE VLNS	TIME (SEC)	ABS. ERROR	EDGE VLNS
1	2	0	83	2	0
2	2	0	84	7	0
3	44	1	85	23	0
4	25	0	86	17	0
5	46	1	87	14	0
6	51	0	88	43	0
7	25	1	89	3	0
8	21	0	90	1	0
9	27	0	91	4	0
10	30	0	92	6	0
11	50	0	93	7	0
12	35	0	94	4	0
13	12	0	95	1	0
14	12	0	96	13	0
15	9	0	97	35	0
16	13	0	98	53	0
17	8	0	99	17	0
18	5	0	100	10	0
19	8	0	101	2	0
20	7	0	102	1	0

CTS INTERVAL PRODUCTION TASK (STATISTICS)

SUBJECT: CAS
TRIAL: DAY8GROUPD

TRIAL TYPE: EXPERIMENTAL
DEADLINE: NONE

MEAN INTERVAL = 511.213
STAND. DEV. = 55.799

OF INTERVALS = 352
IPT VARIABILITY SCORE = 30.872

CTS INTERVAL PRODUCTION TASK (RAW DATA)

SUBJECT: CAS
TRIAL: DAY8GROUPD

TYPE OF TRIAL: EXPERIMENTAL
DEADLINE: NONE

N	INTERVAL LENGTH	SUM OF INTERVALS	SUM SQ. INT. LEN.	DIFF.	SUM OF ABS. DIFF.
1	445	445	198025	0	0
2	517	962	465314.001	72	72
3	540	1502	756914.001	23	95
4	543	2045	1051763	3	98
5	506	2551	1307799	-37	135
6	494	3045	1551835	-12	147
7	546	3591	1849951	52	199
8	498	4089	2097955	-48	247
9	527	4616	2375684	29	276
10	532	5148	2658708	5	281
11	532	5680	2941732	0	281
12	508	6188	3199796	-24	305
13	527	6715	3477525	19	324
14	541	7256	3770206	14	338
15	488	7744	4008350	-53	391
16	513	8257	4271519	25	416
17	527	8784	4549248	14	430
18	493	9277	4792297	-34	464
19	526	9803	5068973	33	497
20	498	10301	5316977	-28	525
21	503	10804	5569986	5	530

Appendix C

SUBJECT INSTRUCTIONS FOR THE CTS V1.2 TASKS

PROBABILITY MONITORING - INSTRUCTIONS TO SUBJECT

In this task you will be monitoring a number of displays which are intended to have the appearance of electromechanical dials like those on a machine. The dials consist of six pointer positions and a pointer which appears below the positions and moves from one to another. Under normal conditions, the pattern of pointer movement is random. The pointer is equally likely to move to any position. Periodically, the pointer movement on one of the dials will become nonrandom, such that the pointer will tend to stay on one side of the dial more than the other. Your task is to watch the dials carefully for nonrandom or "biased" patterns of pointer movement. Biases in pointer movement are called "signals." If you think you see a signal, press the button on the keypad that corresponds to the dial. When you correctly respond to a signal, it is eliminated, and the pointer goes back to moving randomly again.

Monitoring periods last 3 minutes each. You start the monitoring period when you are ready by pressing any of the response keys. During each 3-minute period, you can expect to see two or three signals (biases). If you do not respond, a signal lasts for 30 seconds, so there is ample time to make a decision before respnding. When you make a response, the computer generates a tone to let you know that it was received. More than one signal may appear on a given dial during the 3-minute test period, but two signals will never appear on different dials at the same time. Try to avoid responding unless you are confident that a signal is present. Responses to nonexistent signals are scored against you. The screen will automatically go blank at the end of the monitoring period.

Two aspects of the monitoring task will vary from trial to trial. The first is the number of dials to be monitored. You will be monitoring either one, three, or four dials at a time. The other variable is the proportion of time the pointer spends on the favored side of the dial when a signal occurs. In the one dial condition, the pointer will stay under the favored

half of the dial 95 percent of the time, and will appear on the nonbiased side only 5 percent. In the three dial condition, this proportion is more equal: 85 percent of pointer moves will be on one side, and 15 percent on the other. The proportion of moves is most equal in the four dial condition, 75-25 percent. The effect of equalizing the proportion of time spent on each side of the dial is to make the pointer movement approach the type of random movement that occurs when no signal is present. Therefore, a 75/25 signal tends to look more like random, nonsignal pointer movement than an 85/15 or 95/5 signal.

CONTINUOUS RECALL - INSTRUCTIONS TO SUBJECT

In the continuous recall task, you will see a series of one, two, or four digit number pairs, one number appearing above the other. Only one pair of numbers is presented on the screen at a time. Your task is to memorize the bottom number, and decide whether the top number is the same as the bottom number that you memorized one, two, or three screens earlier. In one task condition, the numbers will be single digits (1 through 9), and the top number must be compared to the bottom number from the previous screen (one digit - one back). When the numbers are composed of two digits (10 through 99), the top number is compared to the bottom number appearing two screens back (two digits - two back); and when the numbers are four digits long (1000 through 9999), the top number is compared to the bottom number that appeared three screens back (four digits - three back). For example, in the one digit - one back condition, if the stimuli were:

Screen 1	Screen 2	Screen 3	Screen 4
0	4	7	3
4	7	2	1

the correct responses would be: Screen 1 - either same or different (neither response is incorrect because there is nothing one screen back from the first screen; press either key when you have memorized the bottom number); Screen 2 - "same," because the top number "4" matches the bottom number on the previous screen; Screen 3 - "same," since the "7" on top is the same number as the bottom "7" on Screen 2; Screen 4 - "different," because

the "3" does not match the "2" on Screen 3. The procedure is essentially the same when comparing larger numbers, except that considered responses are not required for the first two or three screens (when comparing two or three screens back), and the top numbers are compared to bottom numbers that appeared even earlier in the sequence.

In order to successfully perform this task, you will have to do two things every time the screen changes. First, you must memorize the bottom number, and then you must indicate whether the top number on the current screen is the same or different than the bottom number on one of the previous screens. Remember that you must memorize the bottom number before you respond, because a new screen will appear when you press a key, and the information will be lost. Also, keep in mind that in the one digit - one back condition, the response to the first screen does not matter; in the two digits - two back condition, the first two responses are not counted; and in the four digits - three back, the first three responses are not counted. On these first "memorization only" screens, the top number will always be a zero.

You will be starting each data collection period by pressing either response key. Data collection trials last 3 minutes. You should try to respond as quickly and accurately as possible. When you enter a response, the next screen will immediately be displayed. If you find yourself making erroneous responses from trying to go too fast, slow down. However, do not take any more time than is necessary to remember the bottom number and correctly respond to the top number. At the end of the 3-minute period, the task will stop and the screen will go blank.

MEMORY SEARCH - INSTRUCTIONS TO SUBJECT

The memory search task consists of two parts. In the first part of the task, you will be memorizing a small set of letters from the alphabet. This is called the "memory set." In the second part of the task, you will see a series of letters presented one at a time. Your task is to decide whether each letter is one of the letters in the memory set. If a letter is one of the memory set items, you press the "yes" key; if it is not one of the

memory set items, you press the "no" key. The object of the task is to respond to the letters as quickly as possible without making any errors. Respond as fast as you can to the letters, but if you find yourself making errors, slow down. You should try to respond correctly to every item.

You will have as much time as you need to memorize the letters in the memory set. Even when there are six letters, it should not take you too long to remember them - probably not more than 15 to 20 seconds. The actual letters in the memory set will be different on each trial, so you will have to memorize a new set at the beginning of each trial. When you are sure that you know the memory set, you can start the second part of the task by pressing any of the response keys. As soon as you do this, the first letter will appear, and you should start responding. The second part of the task always lasts exactly 3 minutes. At the end of 3 minutes, the screen will go blank.

LINGUISTIC PROCESSING - INSTRUCTIONS TO SUBJECT

This task requires you to classify pairs of letters or words as "same" or "different" on the basis of their shape, grammatical category, or meaning. In one level of the task, pairs of upper or lower case versions of the letters A, B, C, and E are presented one at a time on the screen, and you are to decide whether the two letters are physically identical. If the stimulus pair AA were presented, you would respond by pressing the key labeled "same," since the two letters have exactly the same shape. If youu saw Aa, you would respond on the "different" key. Although both letters are A's, they have a different shape. This level of the task is called the "physical identity match."

Another level of the task is called the "category match." Pairs of upper and lower case versions of the letters A, B, C, and E are again shown one at a time, and you must decide whether both of the letters are vowels or consonants ("same") or whether one letter is a vowel and the other a consonant ("different"). As an example, EC would be "different" since E is a vowel and C is a consonant. Bc would be "same" because both B and c are consonants.

The third level of the task is known as the "antonym match." In this condition, pairs of words are presented together on the screen, and you must decide whether the words are opposite in meaning ("same") or not ("different"). For example, the words LAWFUL - CRIMINAL have the opposite meaning and, therefore, should be given "same" response. ETERNAL - NONSENSE are not opposite in meaning, so a "different" response would be correct.

The task is performed in 3-minute trial periods. You start the data collection when you are ready by pressing any of the response keys. Stimuli will appear one pair at a time, and you should attempt to respond as quickly and accurately as possible. As soon as you enter a response, the next problem will appear. Respond as quickly as you can when answering each item, but if you find yourself making errors from going too fast, slow down. You should try to get every item right. Three minutes after you press a response key to start the trial, the task will automatically stop, and the screen will go blank.

MATH PROCESSING - INSTRUCTIONS TO SUBJECT

In the math processing task, you must solve a number of simple addition and subtraction problems to determine whether the correct answer is greater or less than 5. The two possible responses on the task are "greater than" (>) and "less than" (<). "Greater than" responses are entered on the rightmost key and "less than" responses on the leftmost key. No problem will ever have the value 5 as the correct answer.

You start the task whenever you are ready by pressing any of the response keys. Testing periods last for 3 minutes each. Math problems appear one at a time on the screen, and should be solved from left to right. Always perform the additions and subtractions in the order that they appear in the problems. As soon as you respond to a problem, a new problem will appear. Try to perform the task as quickly and accurately as possible. Go as fast as you can, but if you start to make errors because you are try to go too fast, slow down. You should try to respond correctly to every problem. At the end of the 3-minute testing period, the task will automatically stop and the screen will go blank.

The number of additions and subtractions that are involved in each problem will vary from one 3-minute period to another. On some periods, there will be only one addition or subtraction to perform; on others, there will be two additions and/or subtractions; and on others, there will be three operations to perform. However, in a given 3-minute test period, all problems will have the same number of mathematical operations.

SPATIAL PROCESSING - INSTRUCTIONS TO SUBJECT

In the spatial processing task, a series of bar graphs, or histograms, are presented one at a time. Your task is to memorize the shape of the first of the two histograms, and then decide whether the second histogram is the same shape or a different shape from the first. The first histogram is labeled with a "1" and the second with a "2" so that you can keep them straight. Always memorize the shape of the first histogram and make a same/different response when the second histogram is displayed. "Same" and "different" responses are made on the left and right keys of the keypad.

There are three versions of the task. In the first version, the histograms are composed of only two bars, and the second histogram in the pair is oriented in an upright position. In the second version of the task, the histograms contain four bars, and the second histogram in the pair will appear rotated on its side, either to the left or right. The third version has six bar histograms, with the second histogram in an upside-down orientation. The first histogram in each pair will always be presented in an upright position.

You control when the task starts by pressing any of the response keys. Memorize the shape of the first histogram and respond either "same" or "different" to the second. The first histogram will stay on for a set amount of time, but the second histogram will be erased as soon as you respond, and the next pair of histograms will start. Try to respond as quickly and accurately as possible. Go as quickly as you can, but if you start making errors because you are rushing your decision, slow down. Data collection lasts for 3 minutes from the start of the trial. After 3 minutes, the task will automatically stop and the screen will go blank.

GRAMMATICAL REASONING - INSTRUCTIONS TO SUBJECT

Stimuli in the grammatical reasoning task are sentences that vary in their structural complexity. The sentences are accompanied by symbols, and either correctly or incorrectly describe the order of the symbols. The object of the task is to determine as quickly and accurately as possible whether the sentences correctly describe the order of the symbols, and respond either positively or negatively.

There are three categories of grammatical problems. The first category is composed of single sentence problems which describe the order of two symbols. In the single sentence condition, you are to decide whether the sentence accurately reflects the order of the two symbols. In the following example:

* IS PRECEDED BY @ @*

the * is in fact preceded by the @, so the correct response would be positive (yes). The structure of the sentences in the single sentence condition is highly variable. Sometimes the sentence will be worded simply, but other times the wording will not be so straightforward.

The second level of the task is composed of pairs of sentences which describe the ordering of three symbols. The wording of the sentences in this level of the task is always simple. The object is to determine whether both the sentences are correct or incorrect, or whether one sentence is correct and the other not. If one sentence is correct and the other incorrect, you should respond "nonmatch." If both are either correct or incorrect, respond "match." For example:

\# PRECEDES @
* FOLLOWS @ #@*

The # does precede the @, so the first sentence is correct, and the * does follow the @, so the second sentence is also correct. Since both sentences

are correct (rather than one correct and one incorrect), the sentence answers match, and the correct response is "same."

In the third level of the task, two sentences again describe the order of three symbols, but the sentences are worded in a more complicated fashion. As in the other two sentence conditions, the object is to compare the correctness of the sentences. For example:

```
* IS NOT PRECEDED BY @
# IS PRECEDED BY *        @*#
```

In this case, the * is preceded by the @, so the first sentence is incorrect, and the # is preceded by *, so the second sentence is correct. Since one sentence is correct but the other not, the correct response would be "different."

You should try to respond as quickly and accurately as you can to each grammatical problem. If you find yourself making repeated errors because you are not taking enough time for your decisions, slow down. However, do not take any more time than is necessary to determine the correct answer and respond. You will be starting the data collection periods by pressing a key on the response pad. The trials will last 3 minutes each. At the end of 3 minutes, the task will stop by itself, and the screen will go blank.

UNSTABLE TRACKING - INSTRUCTIONS TO SUBJECT

The object of the unstable tracking task is to keep a cursor centered over a target area in the middle of the screen. You can control the movement of the cursor by turning the control knob. Rotating the knob to the right (clockwise) moves the cursor up, and rotating it left (counterclockwise) moves it down. The cursor appears at the center of the screen and naturally tends to move away from the center. Try to keep the cursor centered over the target at all times. If the cursor reaches the edge of the screen, it will reappear at the target and begin moving away again. This is called a control loss, and should be avoided if possible.

The task is run in 3-minute periods of data collection called trials. The difficulty of the control task will vary from trial to trial. In some trials, the cursor will be fairly easily kept in the middle of the screen, but others will be more unstable. You control when the task starts by rotating the control knob until a number displayed on the screen reaches zero. The task automatically shuts off at the end of 3 minutes, and the screen will go blank.

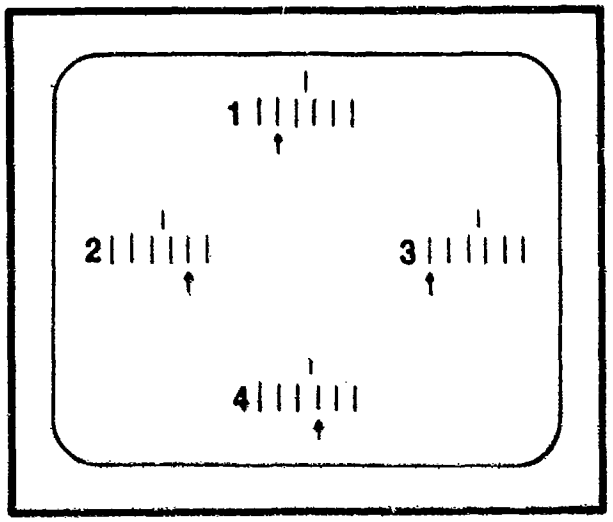
INTERVAL PRODUCTION - INSTRUCTIONS TO SUBJECT

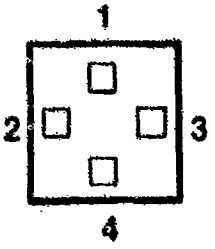
The purpose of the interval production task is to test your timing ability. To do this, we will have you tap a key at a constant rate. By tapping the key at a steady rate, you are producing time intervals between the taps. The more consistently you tap the key, the more equal will be the time intervals that you produce. Try to tap the key softly, but make sure that you press the key to the base on your taps. The best tapping rate is about two taps per second. We will do a few practice trials so that you can tell about how fast that is. The tapping task is run in 3-minute periods. You will be signal' d at the beginning of the tapping period and again when the 3 minutes ha passed.

Appendix D

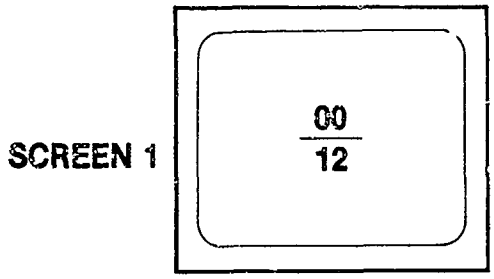
INSTRUCTIONAL GRAPHICS FOR THE CTS V1.2 TASKS

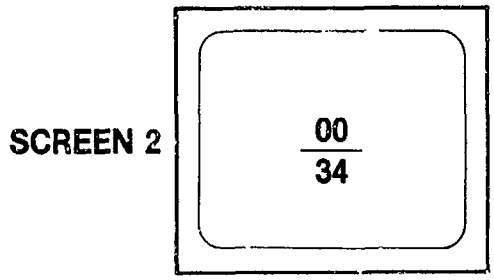
PROBABILITY MONITORING

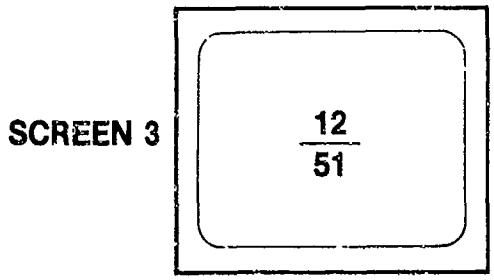


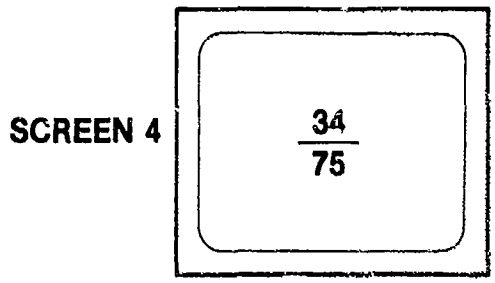


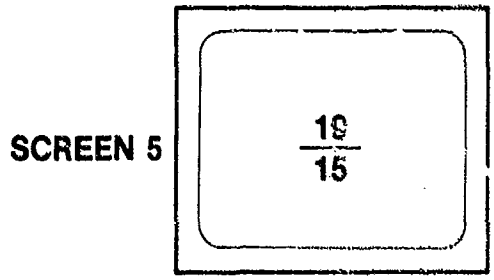
- WATCH THE DIALS FOR BIASES IN POINTER MOVEMENT
- RESPOND ON KEY CORRESPONDING TO BIASED DIAL
- VARIABLE NUMBER OF DIALS AND STRENGTH OF BIAS







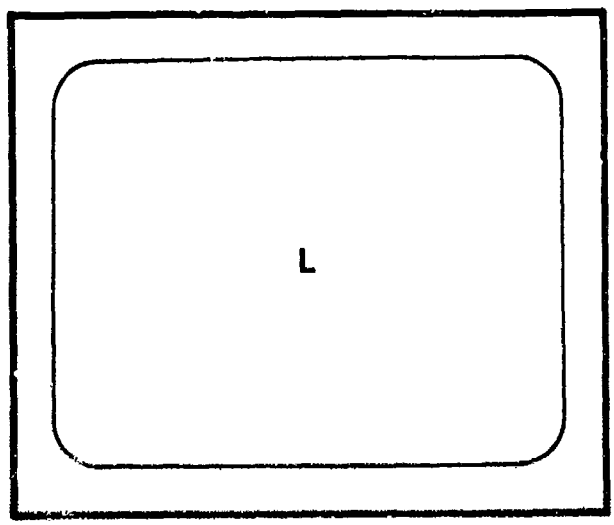


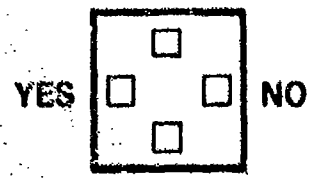


CONTINUOUS RECALL

- MEMORIZE THE BOTTOM NUMBER AND COMPARE THE TOP NUMBER MEMORIZED ONE, TWO OR THREE SCREENS BACK
- NUMBERS CONTAIN 1, 2, OR 4 DIGITS
- SAME/DIFFERENT RESPONSES

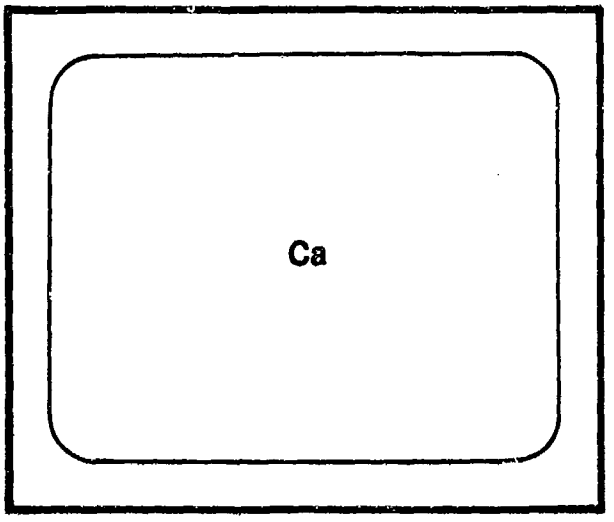
MEMORY SEARCH

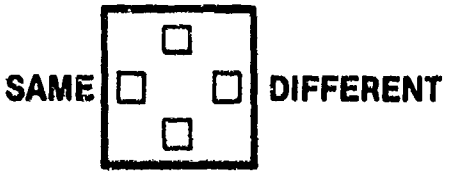




- MEMORIZE THE "MEMORY SET"
- DETERMINE WHETHER EACH ITEM WAS IN THE MEMORY SET
- YES/NO RESPONSES
- VARIABLE MEMORY SET SIZE

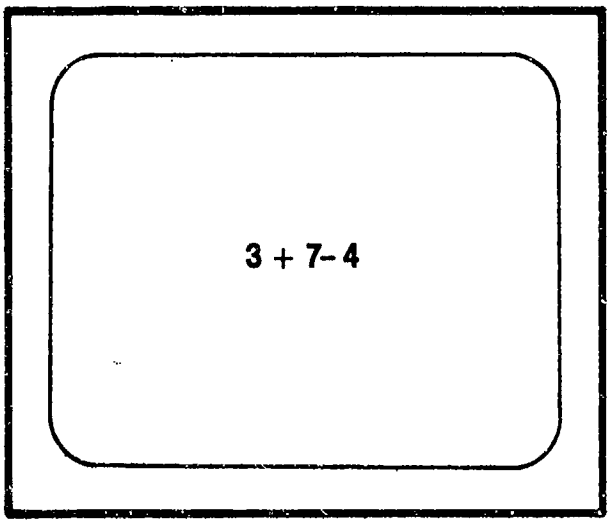
LINGUISTIC PROCESSING

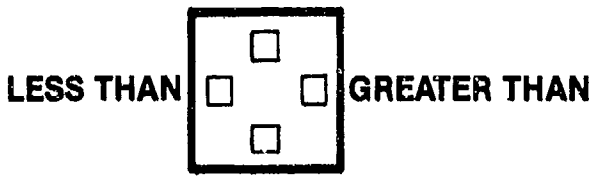




- DETERMINE WHETHER ITEMS MATCHED BASED ON CLASSIFICATION RULES:
  1. PHYSICAL IDENTITY
  2. LETTER CATEGORY (CONSONENTS - VOWELS)
  3. ANTONYMS
- SAME/DIFFERENT RESPONSES

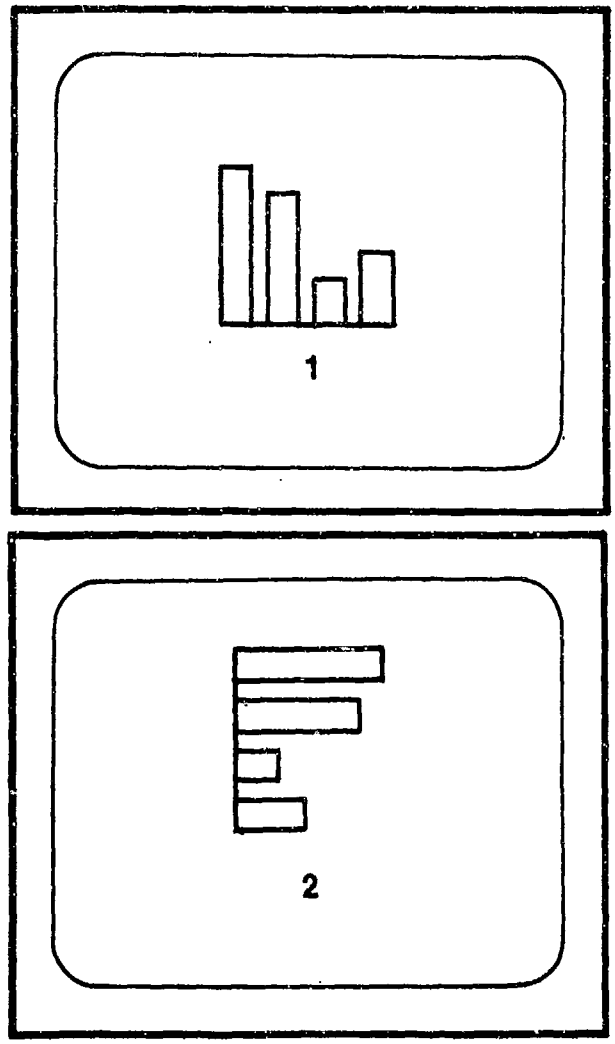
MATHEMATICAL PROCESSING





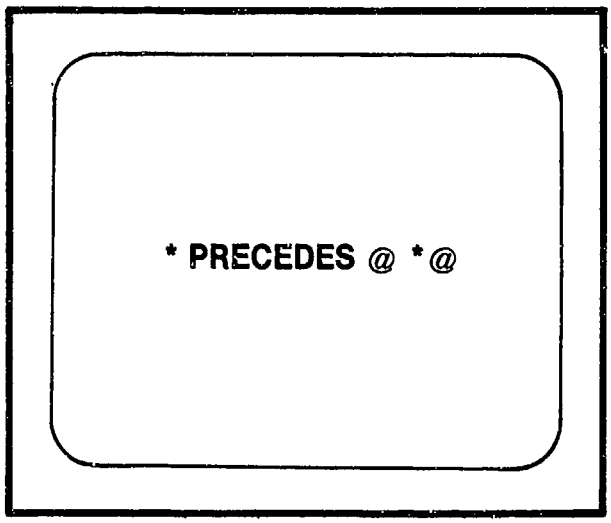
- SOLVE EACH PROBLEM TO DETERMINE WHETHER CORRECT ANSWER IS GREATER OR LESS THAN 5
- GREATER THAN/LESS THAN RESPONSES
- VARIABLE NUMBER OF ARITHMETIC OPERATORS

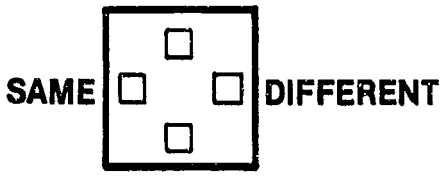
SPATIAL PROCESSING



- MEMORIZE SHAPE OF HISTOGRAM LABELED "1"
- DECIDE WHETHER HISTOGRAM "2" IS THE SAME AS HISTOGRAM "1"
- SAME/DIFFERENT RESPONSES
- DEGREE OF ROTATION OF SECOND HISTOGRAM AND NUMBER OF BARS IN HISTOGRAMS VARIES

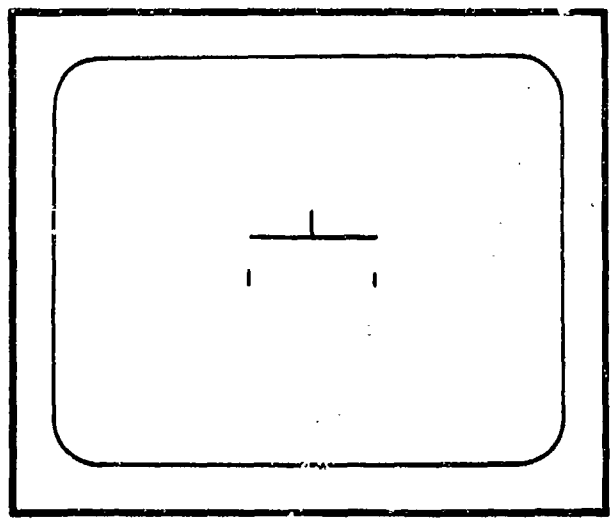
GRAMMATICAL REASONING

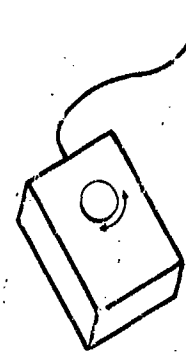




- DETERMINE WHETHER SENTENCE CORRECTLY DESCRIBES ORDER OF TWO SYMBOLS, OR
- DETERMINE WHETHER TWO SENTENCES MATCH IN THEIR "CORRECTNESS"
- SAME/DIFFERENT RESPONSES

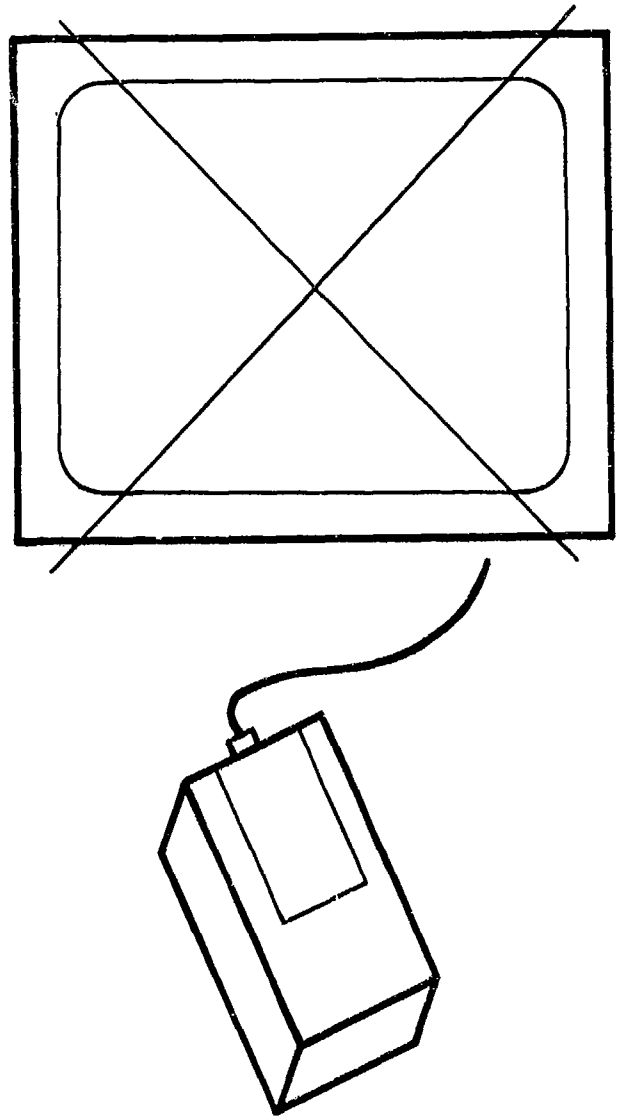
UNSTABLE TRACKING





- MAINTAIN CURSOR IN CENTER OF SCREEN BY ROTATING THE CONTROL KNOB
- CURSOR VARIES IN ITS INSTABILITY

INTERVAL PRODUCTION



- TAP THE KEY AT ABOUT TWO TIMES PER SECOND, MAINTAINING A CONSTANT RATE

REFERENCES

Shingledecker, C. A., November 1984. A Task Battery for Applied Human Performance Assessment Research, AFAMRL-TR-84-071, Air Force Aerospace Medical Research Laboratory, Human Engineering Division, Wright-Patterson Air Force Base, Ohio 45433.

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